Graduate S&E Students and Degrees in the United States

One of the indicators of national innovation capacity and potential international competitiveness is the size and growth of graduate programs in S&E (Porter 1999). This acknowledgment of the importance of education to economic growth is prompting countries to reform and expand graduate education. (See sidebar, "Graduate Reforms in Europe, Asia, and Latin America.")

Trends in Graduate Enrollment

The long-term trend of increasing enrollment in U.S. graduate programs of S&E persisted for more than four decades, followed by four years of declining enrollment, since 1993. The increase in enrollment occurred in two strong waves, reached a peak in 1993, and then subsequently declined in several S&E fields: natural sciences, social sciences, and engineering. (See appendix table 4-21.) The first wave of increasing graduate student enrollment began in the late 1950s and continued throughout the 1960s, with particularly strong Federal support for physics and engineering education and research. The second wave of increasing enrollment occurred in the late 1980s with strong Federal support for academic R&D. (See chapter 2.) A large influx of foreign students into U.S. graduate S&E programs also occurred in the late 1980s. (See appendix table 4-22.) Graduate S&E enrollment more than tripled, from approximately 140,600 students in 1963 (U.S. HEW 1963) to 435,900 in 1993, representing a 2-percent average annual increase over this period.[14] The subsequent drop in the number of graduate S&E students, from 1993 to 1997, represented an average annual decline of 2 percent. (See appendix table 4-21.)

However, the time period and intensity of growth and subsequent declines differ for various fields. Graduate enrollment in the social sciences grew in the 1960s and 1970s, dipped in the early 1980s, and then had a decade-long sharp increase until the mid-1990s. Recent slight decreases in enrollment began in 1995 in psychology and in 1997 in the social sciences. (See appendix table 4-21 and NSF 2000.)

Enrollment in the natural sciences, on the other hand, accelerated in the 1960s, echoing sharp increases in physical sciences support from several government agencies (National Aeronautics and Space Administration, Department of Defense, and Department of Energy), followed by modest growth from 1975 to 1990. The subsequent rapid growth in the early 1990s correlated with expanded research support in the biological sciences. Recent declines in enrollment in the natural sciences, however, are mainly from fewer students enrolling in physical and biological sciences. (See appendix table 4-21 and NSF 2000.)

[14]The graduate student enrollment survey used by the U.S. Department of Health, Education, and Welfare in 1963 and that used by the National Science Foundation in 1993 have slightly different base populations, so only approximate comparisons can be made between the number of graduate students in these two periods.

Engineering followed an upward growth trend until 1992, with declining enrollment every year since then. Both U.S. and foreign students contributed to the rather sharp increase in engineering from 1986 to 1992; the decline since 1993 has been based on fewer U.S. and foreign students entering graduate engineering programs. (See appendix tables 4-21 and 4-22.)

Graduate enrollment in mathematics and computer sciences grew rapidly from 1980 to 1986, similar to engineering, with more modest growth until 1992, followed by a leveling off and slight decline (in mathematics). Foreign students accounted for much of the growth in the 1980s. The favorable U.S. job market after 1992 may account for some of the decline in graduate enrollment. (See appendix table 4-21 and 4-22 and NSF 1999a for disaggregated data on mathematics and computer sciences.)

Master's Degrees

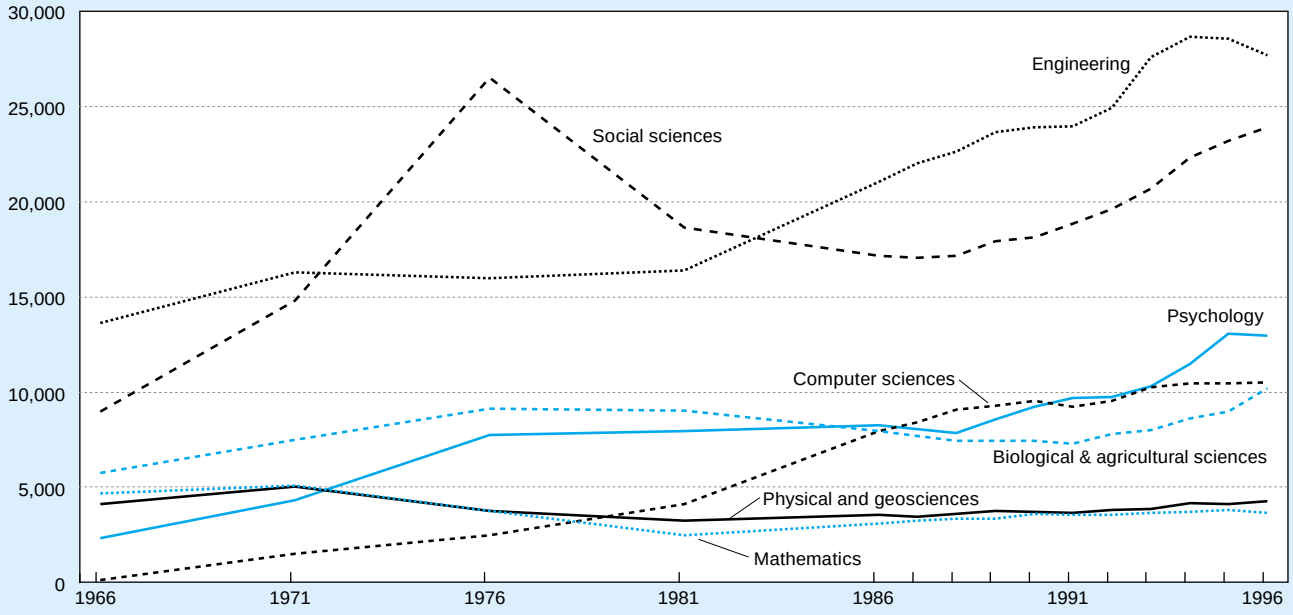
Although graduate enrollment in S&E programs contracted in 1994, master's degrees in S&E continued to increase through 1996. (See appendix tables 4-21 and 4-23.) In fact, increases in S&E degrees at the master's level persisted for more than four decades, with accelerated growth in the first half of the 1990s and a leveling off in 1996. Master's degrees expanded from the modest number of 13,500 in 1954 to more than 95,000 in 1996.

At the master's level, growth in the number of students earning degrees occurred at different times for different fields. The increase in degrees in the physical and mathematical sciences peaked in the early 1970s and then declined, whereas growth in computer sciences continued to increase throughout the 1980s and 1990s. The number of earned degrees in the social and behavioral sciences peaked in the late 1970s, declined for more than a decade, and then showed a reversal of this trend in 1989 with continual annual increases. Biological and agricultural sciences followed this same pattern of a peak in the late 1970s and declined until 1990. Since then, agricultural sciences have increased even more sharply than the biological sciences (NSF 1999b). Engineering, on the other hand, has had almost continual growth over more than four decades, with slight declines in both 1995 and 1996. (See figure 4-16 and appendix table 4-23.)

Doctoral Degrees

The Steelman report's recommendation to train scientists and engineers in all fields of knowledge has been carried out. Doctoral S&E degree production in U.S. universities shows two waves of strong growth in the last half of the 20th century. The first upsurge of doctoral S&E degrees in the late 1950s and 1960s reflected the Cold War and the space race, as well as the result of the wave of GIs taking S&E-oriented bachelor's programs following World War II. (See appendix table 4-24.) This buildup of doctoral programs was followed by a long, slow decline in NS&E fields beginning in the early 1970s (from the cutback in the space program) and in the social sciences in the 1980s. In the 1980s, the second wave of growth occurred in NS&E fields with large increases in aca-

Figure 4-16.
Master's degrees awarded in S&E, by broad field: 1966–96



NOTES: Data are in five-year increments for 1966–86, and one-year increments for 1986–96. Geosciences include earth, atmospheric, and oceanographic sciences.

See appendix table 4-23.

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demic R&D budgets. (See appendix table 4-25 and chapter 6.) From 1986 to 1992, increasing numbers of foreign students entered these expanded graduate NS&E programs. (See appendix table 4-26.)

Within the natural sciences, doctoral degrees in the biological and agricultural sciences had a long, steady, upward trend from 1970 to 1997, while degrees in the physical sciences peaked in the late 1960s, declined to 1980, grew quite steadily to 1995, and then leveled off. (See figure 4-17.) Doctoral degrees earned in the social sciences show a continual steady increase throughout the 1990s. The slight drop in doctoral degrees in NS&E fields in 1997 is mainly accounted for by the decline in the number of foreign doctoral recipients in that year. (A decline in foreign graduate enrollment in U.S. universities occurred from 1993 to 1996.) (See "Diversity Patterns in S&E Enrollment and Degrees in the United States" for doctoral degrees by race/ethnicity and citizenship.)

Steelman's concern for creating the "right" number of S&E doctorates to meet the needs of the workplace relates to the current issue of "overproduction" of doctoral degrees. The "right" number remains elusive. Attempts to model the complexity and change in the U.S. economy and predict demand for doctoral-level personnel by specific S&E fields have been unsuccessful. Rather than attempting to forecast demand or the "right number" of S&E doctorates, policymakers are recommending doctoral education that broadens career options. Because a larger proportion of S&E doctoral recipients than ever before have to seek employment outside academia (COSEPUP 1995), reforms are directed to broadening doctoral education for employment skills both within and beyond academia. (See sidebar, "Graduate Reforms in Europe, Asia, and Latin America.") For example, one large effort for better preparing doctoral students for teaching careers is "The Association of American Colleges and Universities' Preparing Future Faculty program." In addition, NSF has established Engineering Research Centers that provide more interdisciplinary learning and collaboration with industry for engineering students. (See the NSF Web site <<www.eng.nsf.gov/eec/erc.htm>>.)

International Comparison of Doctoral Degrees in S&E

The scale of doctoral programs has increased in several world regions, particularly Europe, Asia, and the Americas. This capacity building in doctoral S&E education is linked to national policies to develop an S&E infrastructure that more explicitly links universities to innovation and economic development. (See sidebar, "Graduate Reforms in Europe, Asia, and Latin America." at the end of this section.) By broad world region,[15] Western Europe produces more doctoral S&E degrees than North and South America (the Americas) and Asia.

[15]This discussion of international comparisons presents data in terms of three world regions—Asia, Western Europe, and North America. The specific countries composing these regions are listed in appendix table 4-27.